Confirmatory Factor Analysis of the Adult Asperger Assessment: The association of symptom domains within a clinical population.

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Word Count: 4391

Abstract

Autism Spectrum Disorder (ASD) is a behaviourally defined disorder characterised by impairments in three domains of social interaction, communication, and repetitive, stereotyped behaviours and activities. Proposed changes to diagnostic criteria suggest that the diagnostic triad may no longer fit as the best way to conceptualise ASD, and that social and communication impairments should be considered as a single domain. The aim of this study was to examine the structure of symptom domains within the *Adult Asperger Assessment* (*AAA*; Baron-Cohen, Wheelwright, Robinson, & Woodbury-Smith, 2005), a diagnostic tool for high functioning adults. As theoretical models already exist, confirmatory factor analysis was used to examine data from a clinical population of adults (n = 153) diagnosed with Asperger Syndrome (AS) and High Functioning Autism (HFA). Confirmatory factor analysis was used to fit different models based on the structure proposed by the authors of the *AAA*, the traditional triad and the newly proposed diagnostic dyad. Analysis suggested that none of the tested models were a good fit on the *AAA* dataset. However, it did highlight very high correlations between social and communication factors ($r > 0.9$) within unmodified models. The results of the analysis provide tentative support for the move towards considering ASD as a dyad of 'social-communication' impairments and repetitive/restricted interests behaviours and activities, rather than the traditional triad.

Key words: autism; aspergers syndrome; pervasive developmental disorder; structure, confirmatory factor analysis.

Acknowledgements

The authors are grateful to the Autism Research Centre for allowing access to the

AAA

1. Introduction

Autism Spectrum Disorders (ASD: also known as Pervasive Developmental Disorders [PDD]) are characterized by impairments in the three domains of social interaction, communication, and repetitive/restricted interests, behaviours and activities (RIBA) in current diagnostic manuals (DSM-IV-TR; American Psychiatric Association [APA], 2000; ICD-10; World Health Organisation [WHO], 1992). In line with most other psychiatric diagnoses, ASD has traditionally been conceptualised as a discrete category, but a consensus is emerging that it is in fact a dimensional disorder reflecting developmental difficulties at the extreme end of a continuum (Mandy & Skuse, 2008). Evidence for this dimensionality has been provided by the broader autistic phenotype in siblings of those with ASD (e.g. Piven, Jacobi, Childress, & Arndt, 1997) and by studies showing that ASD traits are continuously distributed in large general population studies (Constantino & Todd, 2003; Posserud, Lundervold, & Gillberg, 2006). However, the nature of the dimensionality of ASD, and particularly the association between the three domains of impairment, continues to elicit debate.

Although not due for publication until 2013, the fifth edition of the diagnostic and statistical manual (DSM-V) acknowledges the questions surrounding the association of symptom domains as it proposes ASD move to 'Autistic Disorder' (APA, 2010). The three symptom domains are merged into two: 'social-communication' deficits as a single domain, and fixated interests and repetitive behaviours (or RIBA) as a second. It also proposes that Asperger syndrome (AS) be subsumed into Autistic Disorder (APA, 2010). Thus, diagnostic criteria for AS would rely on this proposed 'dyad' of domains. Currently, boundaries between the subtypes of ASD remain unclear (in particular autism, high functioning autism [HFA], AS and Pervasive Developmental Disorder – Not Otherwise Specified [PDD-NOS]). Most researchers consider them as a continuum of the same disorder, with varying degrees of symptom severity and intellectual functioning (Freitag, 2007). They are currently conceptualised to share the triad of impairments, although for a diagnosis of AS, no impairment in communication or language delay is evident. Confusion arises around communication difficulties and AS, as authors have highlighted clinical difficulties in

prosody (Paul, Augustyn, Klin, & Volkmar, 2005) and pragmatic impairments (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Landa & Goldberg, 2005). These are not currently required for diagnosis, and are not stated in DSM-V.

The proposed changes to diagnostic criteria for Autistic Disorder suggest a change in the structure associated with ASD. The traditional triad of impairments becomes a dyad, with social and communication impairments being considered as a single domain. Historically, in line with other psychiatric diagnoses, ASD has been considered a 'disease entity' (Rutter, 1978). Within this framework, the symptoms of social impairments, communication impairments and RIBA are presumed to be associated, as they would arise from the shared underlying abnormality (Mandy & Skuse, 2008). The move away from ASD as a discrete category towards a dimensional conceptualisation has reignited debate about the nature of the association between domains of impairment. Although currently all three domains are required for a diagnosis to be made, the association between them remains unclear.

One method authors have used to consider the association between symptoms and the structure of autism is by using factor analysis. Factor analytic techniques are used to pull out underlying structures (known as factors or components) by identifying which items co-vary (Kline, 1994). As such, factor analysis can examine whether or not the social, communication and RIBA domains of ASD co-vary and correlate. If they do, they should not show up as different factors, as individuals who score highly on social items would be expected to score highly on communication and RIBA items, and vice versa. However if they are not correlated, analysis should result in distinct factors. A recent review of the literature (Kuenssberg, McKenzie, & Jones, *in press*) highlighted that despite three decades of exploration there is still no clear answer about the triad's empirical relevance. The majority of analyses resulted in authors recommending a move towards conceptualising social deficits and communication deficits as being a shared social-communication factor, in line with proposed DSM-V amendments (e.g. Frazier, Youngstrom, Kubu, Sinclair, & Rezai, 2008; Georgiades et al., 2007; Kamp-Becker, Ghahreman, Smidt, & Remschmidt, 2009; Snow, Lecavalier, & Houts, 2009; van Lang et al., 2006).

Despite ongoing debate about the structure of ASD, awareness has grown exponentially after Rutter's influential review and generation of the 'Rutter criteria' (Rutter, 1978), and the subsequent publication of the DSM-III in 1980 (APA, 1980). Professionals are now alert and informed of the possibility of children with ASD, and as a result there are a growing number of tools targeted for assessment and diagnosis. Currently, the 'gold standard' for assessment in childhood is the *Autism Diagnosis Interview-Revised* (*ADI-R*; Lord, Rutter, & Le Couteur, 1994) and the *Autism Diagnostic Observation Schedule – Generic* (*ADOS-G*; Lord et al., 2000). However, these tools are time consuming to administer, complex, and require expensive training. They are also not age-appropriate for adults born before the ASD watershed of the 1980s (Baron-Cohen, Wheelwright, Robinson, & Woodbury-Smith, 2005). Diagnosis of autism and AS in adulthood can be difficult, as they share many symptoms with other DSM-IV-TR disorders, such as social anxiety disorder, obsessive–compulsive disorder, and schizoaffective disorder (Baron-Cohen & Wheelwright, 2004; Fitzgerald & Corvin, 2001).

One tool designed to diagnose AS in adults is the *Adult Asperger Assessment* (*AAA*; Baron-Cohen et al., 2005). This links two self-report screening instruments, the *Autism-Spectrum Quotient* (*AQ*: Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) and the *Empathy Quotient* (*EQ*: Baron-Cohen & Wheelwright, 2004). The client's response to each item on the *AQ* and *EQ* is entered into the *AAA* spreadsheet, and a macro is run to score the client's response into one of four sections of the *AAA*; (i) qualitative impairments in social skills (Social); (ii) restricted repetitive and stereotyped patterns of behaviour, interest and activities (RIBA); (iii) qualitative impairments in verbal or nonverbal communication (Comm); and (iv) impairments in imagination (Imag). The *AQ* and *EQ* responses form two functions; all the completed items are used to provide an overall score which can be compared to clinical cut-offs (Baron-Cohen et al., 2005), but 72 of the *AQ* and *EQ* items are also used as examples of impairment within each section of the *AAA* (see Table 1, as described in the example *AAA* in Baron-Cohen et al., 2005). This can then be used as the basis of a qualitative interview, and directly compared to DSM-IV criteria.

----------insert Table1 here ----------

For a diagnosis of AS or HFA, individuals need to display symptoms in each of the four sections detailed above. The *AAA* had been designed to be more stringent than DSM-IV criteria, so anyone who meets the *AAA* criteria will also meet DSM-IV criteria (Baron-Cohen et al., 2005). Differential diagnosis between AS and HFA depends on the absence or presence of developmental language delay respectively. The *AAA* includes six items relating to imagination, although the authors acknowledge debate over imagination deficits in AS, and indeed within ASD. Imaginative behaviours include activities ranging from simple pretend play to creative engagement with fictional stories. There is some debate over whether or not the concept of impaired imagination is linked to repetitive behaviour (as described by Wing & Gould, 1979) or communication impairments, as described within classification systems (within the lack of spontaneous make-believe play: APA, 2000). As described, these diagnostic systems provide a separate category for RIBA. However, explorative factor analytic studies have suggested a three way association between repetitive behaviour, imagination and communication (Honey, Leekam, Turner, & McConaghie, 2007).

The purpose of the current Scottish study was to further investigate the association of social, communication and RIBA domains of impairment in AS and HFA by examining the factor structure of the 72 items detailed in table 1 within the *AAA*, within a clinical sample. As theoretical models about the structure of ASD already exist, confirmatory factor analysis was used to assess competing models. These were based on the four factor structure proposed by the authors of the *AAA* (Baron-Cohen et al., 2005), the triad of impairments, or the newly proposed dyad. Due to the debate surrounding the requirements regarding Imagination, this factor will be including systematically with each of the other domains of impairment. (See figure 1 for a brief schematic of the models tested).

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2. Method

Ethical approval was received from the local NHS ethics committee and Caldicott Guardians, and the local research department.

2.1 Participants

The Regional ASD Consultancy Service (RASDCS) is a multi-professional service aiming to provide diagnosis and advice to individuals over 18years old in Scotland. The service covers four health boards, with case-holders from each health board working on a good-will basis as part of the local managed care network. Closed files of 140 adults who had attended the regional service or been assessed by its associated staff and who had received a diagnosis of AS/HFA were reviewed. Before referring to RASDCS, local psychologists complete some ASD diagnostic assessments using the same tools as RASDCS. Thirteen extra cases were sourced from these clinicians to add to the sample. The total sample consisted of 153 adults. Mean age of the sample was 33 years (standard deviation [SD] = 11), with a range of 17–75years. The sample consisted of 110 men and 43 women (male to female sex ratio of 2.6:1). There was no difference between the mean age of males or females ($p > 0.05$).

2.2 Measures

2.2.1 Adult Asperger Assessment

There have been no large-scale standardisation studies for the *AAA* (Stoesz, Montgomery, Smart, & Hellsten, 2011). The only published study presenting validity evidence for the *AAA* was with a small sample, reported by the authors (Baron-Cohen et al., 2005). There has been no further published empirical evidence of the reliability of the *AAA*. It is reported as having good content validity, in that it appears to be consistent with symptoms and concepts in the literature (Baron Cohen et al., 2005), however, to the best of the authors' knowledge, no further empirical data on the complete *AAA* has been published. The two subscales within the *AAA*, the *AQ* and the *EQ*, have had more empirical assessment. For a review see Stoesz et al. (2011).

Within the *AAA*, the individual's responses can be scored in two ways; 0/1 or 0/1/2 scoring is used to compare with clinical cut-off scores in the *AQ* (Baron-Cohen et al., 2001) and *EQ* (Baron-Cohen & Wheelwright, 2004) respectively; or on a continuous 4 point Likert-scale on the *AQ* (1 = definitely agree, 2 = slightly agree, 3 = slightly

disagree, and 4 = definitely disagree) and the *EQ* (1 = strongly agree, 2 = slightly agree, 3 = slightly disagree, and 4 = strongly disagree). Using the continuous Likert-scale retains more information about participants' responses so helpful for factor analysis (Stewart & Austin, 2009). This utilises valuable information about the degree of endorsement for each item (Austin, 2005). Some of the items are reversed, with a 'disagree' response characteristic of autism, so the data was transformed to account for this reverse scoring. These items are marked with an asterisk (*) in Table 1. Within this analysis, higher scores on both the *AQ* and the *EQ* represent a higher autistic phenotype.

2.3 Procedure

All clients were assessed for the presence of AS/HFA according to DSM-IV-TR criteria by experienced clinicians, although the exact procedure varied depending on the clinician's training and case presentation (e.g. assessment by a psychologist might incorporate neuropsychological assessment, assessment by psychiatrists may include assessment of personality disorder or schizotypal psychopathology as differential diagnosis). Accordingly, cases were allocated on an assessment-needs basis. However, every client underwent clinical interview, and wherever possible an informant was sourced for developmental review. This was a semi-structured interview, ideally with a parent, which covered early development in all domains of autism spectrum conditions. This encompassed: birth history, medical history, family history, motor development, play behaviour, social behaviour, communication and other behaviour such as sensory sensitivities from 0-3 years. Each case was discussed at a multidisciplinary clinic before final diagnosis, but assessment was completed by one professional. Although not dependant on *AAA* scores, diagnoses were not independent of assessment, as it was part of the battery used.

2.4 Confirmatory Factor Analysis of the AAA dataset

Confirmatory factor analysis explicitly tests *a priori* hypotheses between observed variables and latent factors. It is the analytic tool of choice for exploring structure when theories already exist, and in developing and refining measurement instruments (Jackson, Gillaspy, & Purs-Stephenson, 2009).

Model AAA1 was a four factor solution as suggested by the authors of the AAA (Baron-Cohen et al., 2005). This model stipulated four separate domains; (i) qualitative impairments in social interaction (Soc); (ii) Restricted, repetitive and stereotyped patterns of behaviour, interests and activities (RIBA); (iii) Qualitative impairments in verbal or non-verbal communication (Comm); and (iv) Impairments in imagination (Imag). Model AAA2 was a three factor 'triad' of impairments as stipulated by current diagnostic criteria, but included imagination as a function of RIBA (RIBA/Imag). Model AAA3 again used the triad, but with imagination as a function of communication (Com/Imag). For completeness, and considering the debate about the proposed overlap between social and communication symptom domains, Model AAA4 used the diagnostic triad but with imagination as a function of social skills (Soc/Imag). The next two models used a two factor 'dyad' solution as proposed by changes to DSM-V diagnostic criteria, with social and communication impairments as a single symptom domain (Com/Soc). Model AAA5 used this domain along with imagination as a function of RIBA (RIBA/Imag) and Model AAA6 included imagination as a function of this single 'social/communication' factor (Con/Soc/Imag). The final two models excluded imagination from the models completely: Model AAA7 was the DSM-IV-TR described triad, and Model AAA8 the newly proposed DSM-V dyad.

2.5 Goodness –of- fit indices

Jackson et al.'s reporting guidelines checklist (2009) guided the inclusion of multiple fit indices; MLM chi-square (also known as the Sattora-Bentler chi-square), the comparative fit index (CFI; Bentler, 1990), the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), the root-mean-square error of approximation (RMSEA) and the standardised root mean square residual (SRMR). Cut-off 'rules of thumb' were based on Hu and Bentler (1999). In the case of CFI and TLI, values above .95 indicated a good / acceptable fit; RMSEA of .06 or less; and for the SRMR values of .08 or less were desired.

3. Results

The correlation matrix was checked for multicollinearity and singularity. Given that both Bartlett's and the KMO measure were within reasonably acceptable

limits, factor analysis was considered to be an appropriate way to explore the dataset. No outliers were identified.

Skewness and kurtosis z scores were calculated, and it was found that the variables were non-normal in different ways (i.e. some positively and some negatively skewed). A Kolmogorov-Smirnov test suggested that all the items differed significantly from a normal distribution. This was unsurprising given that data distribution from a clinical population may not be expected to be normal (Tabachnick & Fidell, 2007). As the data did not have a normal distribution, a non-parametric test MPlus v5.21 (Muthén & Muthén, 1998-2011) was used to run the confirmatory factor analysis on the correlation matrix. In models with data which are considered multivariate, maximum likelihood mean (with standard errors and a mean-adjusted chi-square test statistic robust to non-normality; MLM) is typically used to estimate the models. The MLM chi-square test statistic is also referred to as the Satorra-Bentler chi-square. MLM uses a list-wise procedure to deal with missing data. This reduced the dataset (n = 110). This means there is a likelihood that there are not enough participants for the number of items within the questionnaire, and results need to be treated with caution. However, the dataset is still over 100, and importantly there were more subjects than factors (Kline, 1994).

3.1 CFA findings

As can be seen from table 2, none of the models had a good or acceptable fit to the data (CFI and TFI < .95, RMSEA > .6, SRMR > .08). The best fitting model, based on the best fitting CFI although still poor, is AAA7, the traditional DSM-IV-TR triad model of social skills, communication and RIBA, that ignores *AAA* items that relate to the Imagination factor. The next closest fitting model was the proposed dyad of Social and communication impairments as a single factor, and RIBA as a separate 'non-social' factor, again ignoring the *AAA* items that relate to the Imagination factor. However, as the meaningfulness of any difference in fit indices (e.g. a difference in RMSEA values) can't be determined, small difference in fit indices should not be over-interpreted.

----------insert Table 2 here ----------

As none of the models provided an acceptable fit, factor loadings are not reported, but are available on request from the first author. In each of the models tested on *AAA* data, social and communication factors correlated highly ($r > .9$, $p < .0001$). Factor correlations within each model fitted to *AAA* data are shown in Table 3.

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This could suggest that it may not be plausible to separate the communication and social factors in each of the models fitted to the data. There was also a high correlation between the Communication factors and Imagination factors in the four factor model ($r = .686$, $p < .0001$), and in the three factor model when imagination items and RIBA items were fitted as a single domain ($r = .708$, $p < .0001$). There was a lower correlation between the Communication factors and RIBA when Imagination items were not grouped together ($r = .503$, $p < .0001$).

4. Discussion

A confirmatory factor analysis is a means of testing how the data fit models proposed by theory. The factor structure is suggested *a priori* either by previous analyses and theoretical constructs. ASD has been proposed to be a triad of impairments, with three separate domains of social skills, communication and RIBA. However, proposed changes to the DSM-V diagnostic criteria for autistic disorder suggest a dyad of impairments, with social and communication as a single symptom domain, and RIBA as a separate 'non-social' domain. These models, as well as a four factor model proposed by the authors of the *AAA* (Baron-Cohen et al., 2005) were fitted to data from a clinical population for adult diagnosed with AS or HFA. Because

the *AAA* also has items relating to 'Imagination', different models were also tested to see if fit was improved incorporating these items into each domain.

None of the models showed a good fit to the *AAA* data, and none met the goodness-of-fit rules of thumb of CFI > .95, TLI > .95, RMSEA < .06 or SRMR < .08. The best fitting models were those that excluded all of the imagination items from the analysis. The traditional triad of social skills, communication and RIBA, and the proposed dyad of a joined social-communication factor and RIBA were the best fitting models, but as neither model was significant it is not meaningful to compare the fit between the two.

However, examination of the correlations between factors suggested potential difficulties in considering social and communication factors as separate domains. In all the *AAA* models fitted to the data, communication and social factors were very highly correlated ($r > .9$, $p < .001$). This suggests significant overlap between the variance explained by each factor. The low correlations between social and RIBA factors could also suggest strength in the dyad structure being proposed.

4.1 Limitations

Results of this study need to be treated with caution due to methodological difficulties, particularly regarding the limited sample size. There are no clear guidelines on the size of a sample suitable for factor analysis, although the general rule of thumb is the more data the better (Kline, 1994). Other recommendations vary from $N - n - 1 \geq 50$ (where N = number of participants and n = number of variables) (Lawley & Maxwell, 1971), N at least 100 (Gorsuch, 1983), to a rating scale where 100 = poor, 200 = fair, 300 = good, 500= very good, 1000 or more = excellent (Comrey & Lee, 1992). This study initially met the $N - n - 1 \geq 50$ rule recommended by Lawley and Maxwell (1971), but was reduced to 'N at least 100' (Gorsuch, 1983) due to missing data.

Also, uncertainly still exists as to whether or not AS differs meaningfully from HFA (Rutter, 2011). At the moment they are generally considered to be distinguishable by the presence of an early delay in language acquisition (HFA) or not (AS). Within this analysis, there was no consistent clarification as to whether each

client had been diagnosed with AS or HFA, so the sample was treated a single subgroup. This was deemed appropriate as they are treated as a single group clinically, so were examined together within the analysis, but it could be that in the future if differences are delineated, the factor structure could differ for each sub-type.

4.2 Clinical Implications

As always, these results can only be generalised to the sample that was used to estimate and test the model (Tabachnick & Fidell, 2007). However, the reported high correlation and potential overlap between social and communication factors seems to make sense clinically: the qualitative impairments in social interaction can result in difficulty interpreting communication, and impaired communication in ASD exists across a broad spectrum affecting both verbal and nonverbal impairments (Cashin & Barker, 2009). Thus, particularly nonverbal deficits such as difficulties with facial expression and gesture are clearly going to have social ramifications. If clinicians are currently using diagnostic tools that have been designed to reflect the triad of impairments with social and communication impairments being treated as separate factors, it could be that the same difficulty is, in effect, 'counted twice' within diagnostic procedures.

Although on one level the results of the analysis could be considered further evidence of the potential diagnostic 'overweighting' in treating social and communication domains as two separate factors, it does seem likely that the *AAA* requires further assessment as a diagnostic tool. This study has not found evidence for the four factor structure proposed by the authors, Baron-Cohen et al. (2005). There may be potential difficulties in using a diagnostic tool that does not appear to have a robust underlying structure that corresponds to theoretical models on which it is based. Unfortunately, all the results relating to the *AAA* need to be treated with caution due to the small sample size.

As CFA did not provide evidence of a good fit for any of the models suggested, an exploratory factor analysis of the *AAA* could be completed to examine the factor structure within the clinical data, and compare it to the four factor structure proposed by the authors (Baron Cohen et al., 2005). The proposed four factor

structure forms the framework for quantitative 'tallying' of symptoms against DSM-IV criteria. It is not clear whether these items within the *AAA* correspond to their stipulated areas, and this requires more examination. However, the 72 items that are the variables for the proposed structure of the *AAA* is just one aspect of the tool: the *AAA* also provides cut-off scores for both the *EQ* and *AQ* that were not examined within this study, and the proposed structure provides a framework for a qualitative interview. Clinically, it seems likely that the latter is the most important part of the diagnostic process.

Further validation of the *AAA* could include a second measure to ensure that it actually measures the ASD phenotype as it aims to. Unfortunately no such 'quality check' was possible within this sample as no other scale was used in the clinical practice where the data were collected. Validation of the *AAA* could include establishing measurement invariance (the 'unbiasedness' of items) to ensure differences in responses are not due to irrelevant characteristics associated with membership of particular groups (e.g. sex, diagnosis of HFA or AS; Wicherts & Dolan, 2010). Assessment of AS, particularly in adults, is a relatively new endeavour and as such there is no 'gold standard' procedure (Stoesz et al., 2011).

5. Conclusion

A review of previous research suggested that social and communication impairments in ASD should be treated as a single symptom domain (Kuenssberg, McKenzie & Jones, *in press*). This would be in line with proposed changes to DSM-V criteria for Autistic Disorder. Models based on the DSM-IV triad, DSM-V dyad and a four factor model proposed by the *AAA* authors (Baron-Cohen et al., 2005) were fitted to data from a high functioning group of adults diagnosed with AS or HFA. None of the models showed a good fit, but high correlations between social and communication factors could support a move away from the diagnostic triad of impairments. Even within the limitations of this study, this provides further support for the dyad of impairments proposed by DSM-V. This study is the first to consider the structure of ASD by using *AAA* data from a high functioning clinical population. Even with the limitations of sample size, it has highlighted that more research is required both on this diagnostic tool, but also on the conceptualisation of ASD with this population.

6. Acknowledgement

Thanks to the staff at the Regional ASD Diagnostic Service for their encouragement and support with data collection and to Dr Matthias Schwannauer for his assistance with the statistical analysis.

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Table 1: Items of the *AAA* and corresponding section, as described by Baron-Cohen et al., 2005).

Section A 'Qualitative impairment in Social Interaction'	**AQ Items** **1.** I prefer to do things with others rather than on my own **10.** In a social group, I can easily keep track of several different people's conversations* **11.** I find social situations easy* **15.** I find myself drawn more strongly to people than to things **20.** When I'm reading a story, I find it difficult to work out the characters' intentions **22.** I find it hard to make new friends **27.** I find it easy to "read between the lines" when someone is talking to me* **35.** I am often the last to understand the point of a joke **36.** I find it easy to work out what someone is thinking or feeling just by looking at their face* **44** . I enjoy social occasions* **45**. I find it difficult to work out people's intentions.
	EQ Items **8**. I find it hard to know what to do in a situation **11**. It doesn't both me too much if I am late meeting a friend **12**. Friendships and relationships are just too difficult, so I tend not to bother with them. **19.** I can pick up quickly if someone says one thing but means another* **21.** It is hard for me to see why some things upset people so much **22.** I find it easy to put myself in somebody else's shoes* **25.** I am good at predicting how someone will feel* **26.** I am quick to spot when someone in a group is feeling awkward or uncomfortable* **32.** Seeing people cry doesn't really upset me **35.** I don't tend to find social situations confusing* **39.** I am able to make decisions without being influenced by people's feelings* **43.** Friends usually talk to me about their problems as they say that I am very understanding* **44.** I can sense if I am intruding, even if the other person doesn't tell me* **48.** Other people, often say that I am insensitive, though I don't always see why **49.** If I see a stranger in a group, I think that it is up to them to make an effort to join in **50.** I usually stay emotionally detached when watching a film **52.** I can tune into how someone else feels rapidly and intuitively* **55**. I can tell if someone is masking their true emotion* **57.** I don't consciously work out the rules of social situations* **58.** I am good at predicting what someone will do* **59**. I tend to get emotionally involved with a friend's problems*
Section B 'Restricted repetitive and stereotyped patterns of behaviour, interest and activities'	**AQ Items** **2.** I prefer to do things the same way over and over again **4.** I frequently get so strongly absorbed in one thing that I lose sight of other things **5.** I often notice small sounds when others do not **6.** I usually notice car number plates or similar strings of information **9.** I am fascinated by dates **12.** I tend to notice details that others do not **16.** I tend to have very strong interests which I get upset about if I

	can't pursue **19.** I am fascinated by numbers **23.** I notice patterns in things all the time **25.** It does not upset me if my daily routine is disturbed* **28.** I usually concentrate more on the whole picture, rather than the small details* **30.** I don't usually notice small changes in a situation, or a person's appearance* **41.** I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).
	EQ Items **10.** People often tell me that I went too far in driving my point home in a discussion **60.** I can usually appreciate the other person's viewpoint, even if I don't agree with it*
Section C 'Qualitative impairments in verbal or nonverbal communication'.	**AQ items** **7**. Other people frequently tell me that what I've said is impolite, even though I think it is polite **17.** I enjoy social chit-chat* **26**. I frequently find that I don't know how to keep a conversation going **31**. I know how to tell if someone listening to me is getting bored* **33.** When I talk on the phone, I'm not sure when it's my turn to speak **38**. I am good at social chit-chat* **39.** People often tell me that I keep going on and on about the same thing **48**. I am a good diplomat*
	EQ items **1.** I can easily tell if someone else wants to enter a conversation* **14.** I often find it difficult to judge if something is strongly rude or polite **15**. In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking **27.** If I say something that someone else is offended by, I think that that's their problem, not mine **28**. If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it **29.** I can't always see why someone should have felt offended by a remark **34**. I am very blunt, which some people take to be rudeness, even though this is unintentional **37.** When I talk to people, I tend to talk about their experiences rather than my own* **41**. I can easily tell if someone else is interested bored with what I am saying* **46.** People sometimes tell me that I have gone too far with teasing. **54.** I can easily work out what another person might want to talk about*
Section D 'Impairments in imagination'	**AQ Items** **14.** I find making up stories easy* **21.** I don't particularly enjoy reading fiction **24.** I would rather go to the theatre than a museum* **40.** When I was young, I used to enjoy playing games involving pretending with other children* **42**. I find it difficult to imagine what it would be like to be someone else **50**. I find it very easy to play games with children that involve pretending*
	EQ items – nil

Figure 1. Brief schematic of models fitted to the *AAA* data

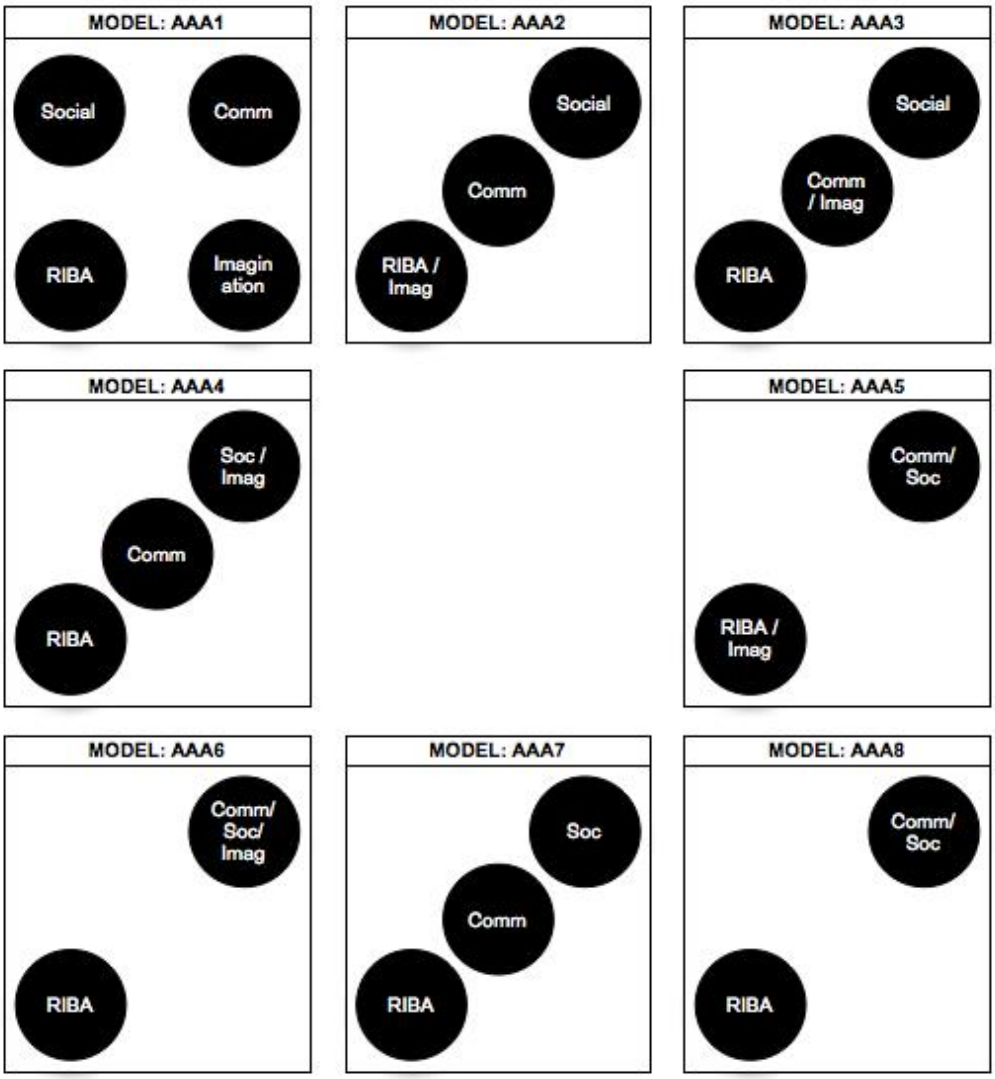

Table 2. Indices of fit for the CFA models

	MLM χ^2	CFI > .95	TLI > .95	RMSEA < .06	SRMR < .08
AAA1	4730.36	.415	.397	.091	.117
AAA2	4827.22	.391	.372	.093	.118
AAA3	4753.88	.410	.392	.091	.116
AAA4	4752.81	.410	.392	.091	.116
AAA5	4840.44	.388	.370	.093	.118
AAA6	4765.65	.407	.390	.091	.117
AAA7	4071.92	.428	.409	.093	.118
AAA8	4087.74	.424	.406	.093	.119

Table 3: Factor Correlations within each Model fitted to *AAA* data

Model	Correlating factor	With…	*r*	*p* =
AAA1	RIBA	SOCIAL	.271	.000
	COMM	SOCIAL	**.958**	.000
		RIBA	.462	.000
	IMAG	SOCIAL	**.705**	.000
		RIBA	.210	.001
		COMM	.686	.000
AAA2	RIBA/IMAG	SOCIAL	.530	.000
	COMM	SOCIAL	**.954**	.000
		RIBA/IMAG	**.708**	.000
AAA3	RIBA	SOCIAL	.263	.000
	COMM/IMAG	SOCIAL	**.961**	.000
		RIBA	.429	.000
AAA4	RIBA	SOC/IMAG	.277	.000
	COMM	SOC/IMAG	**.960**	.000
		RIBA	.465	.000
AAA5	RIBA/IMAG	COMM/SOC	.612	.000
AAA6	RIBA	COMM/SOC/IMAG	.316	.000
AAA7	RIBA	SOCIAL	.295	.000
	COMM	SOCIAL	**.947**	.000
		RIBA	.503	.000
AAA8	RIBA	COMM/SOC	.340	.000

* correlations above .7 are highlighted in bold